United States Department of Agriculture
Forest Service

Sanpoil

Silviculture Report

Republic Ranger District
Colville National Forest

May 26, 2020

Table of Contents

Tables

1.0– Introduction

The Sanpoil planning area is located in the southeastern part of the Republic Ranger District. Tree species are primarily dry Douglas-fir and ponderosa pine with mesic spruce and subalpine fir along riparian areas and lodgepole pine/subalpine fir in the higher elevations of the east side. The area has sustained large scale wildfires in the past, most recently the 1988 White Mountain wildfire. It is currently heavily impacted by insect and disease problems, especially bark beetles and dwarf mistletoe. A severe wind event occurred in 2012 that toppled acres of large ponderosa pine and Douglas-fir. The area has had extensive harvest in the past including large scale fire salvage following the White Mountain wildfire. The Sanpoil planning area is adjacent to the town of Republic which was recently under evacuation level 1 during the Northstar fire (2015) which burned just west of the project area boundary. There is a need for vegetation treatments to reduce the susceptibility to wildfire, forest pathogens and insects and to continue management treatments that were started in the past. This report analyzes the effects of vegetation treatments to improve resilience to disturbances; specifically that of insect and disease and wildfire by improving sustainability in terms of landscape patterns, species composition, and density reduction. The social effects of vegetation treatments in terms of jobs to the tri-county area (Pend Oreille, Stevens, and Ferry Counties) will also be considered.

2.0 - Relevant Laws, Regulations, and Policy: Regulatory Framework

2.1.1 – National Forest Management Act (NFMA)

Land Management Plan

As required by NFMA and the planning rule, all projects and activities authorized by the Forest Service must be consistent with the Colville National Forest Land Management Plan (LMP). A project or activity must be consistent with the LMP (36 CFR 219.8(e)) by being consistent with applicable plan components (36 CFR 219.7(a)); 36 CFR 219.8(a). This report incorporates the LMP by reference and is tiered to the Land Management Plan's Final Environmental Impact Statement (USDA Forest Service 2019). Direction in the LMP applies to all projects that have decisions made on or after the effective date of the final record of decision. The record of decision specifies the transition strategy for short- and long-term ongoing actions. Plans may have other content, such as background, collaboration strategies, context, existing conditions, glossary, introduction, monitoring questions, other referenced information or guidance, performance history, performance measures, performance risks, program emphasis, program guidance, program priorities, possible actions, roles and contributions, management challenges, or strategies, but such other content are not matters to which project consistency is required. A project or activity must be consistent with all applicable plan components; desired conditions, standards and guidelines. The following paragraphs describe how a project or activity may or may not be consistent with plan components and the requirements for documenting consistency. Desired conditions, objectives, standards, guidelines, and suitable uses for forest vegetation as provided in the LMP for the entire Forest (pp.34-39) and individual management areas likely affected by the Sanpoil project are disclosed in Section 8 of this report, followed in each case by a rationale for a finding of consistency.

2.1.2 - Insect and Disease Area Designation

Most of the project area was selected by the Governor of Washington State as an Insect and Disease Area Designation under the 2014 Farm Bill (Agricultural Act of 2014, Section 8204 of the Farm Bill) due to epidemic levels of bark beetles and spruce budworm. These areas were selected to address insect and disease threats that weaken forests and increase the risk of forest fire.

2.1.3 - Other Guidance or Recommendations

Vision 2020 & Collaborative Forest Landscape Restoration Project (CFLRP)

The Sanpoil project is one of several projects occurring within the Forest's Collaborative Forest Landscape Restoration Act project, Vision 2020. The Vision 2020 CFLRP landscape restoration strategy calls for increasing ecosystem resistance and resilience to disturbance, restoring old-growth structure and function, and reducing wildfire risk and fire management costs by: thinning small trees, reducing fuel loads and ladder fuels; increasing fire breaks through landscape heterogeneity and employing fire as a management tool; and establishing a low-fuels buffer on the northern boundary of the Colville Indian Reservation (CFLRP proposal page 2). Additional information about the Vision 2020 proposal can be found on the web at:

http://www.fs.fed.us/restoration/documents/cflrp/2011Proposals/Region6/Colville/NEWForestVisionCFLRP2020ver2.pdf

Ecosystem Management Decision Support (EMDS) landscape analysis

A landscape analysis was done for the Sanpoil analysis area using the EMDS Landscape analysis process and software according to protocols described in Hessberg, et al., 2013. The process uses modeling based on a series of inputs from aerial photo interpretation to identify past, current, future, and/or desired (reference) conditions for a variety of parameters. Departures from reference conditions were identified and are briefly discussed in Section 3. A spatially-explicit analysis prioritizing treatments and treatment locations was not conducted using the EMDS.

There are three main 6th field watersheds that were analyzed for the Sanpoil analysis area. One of these, Scatter Creek, is located entirely west of highway 21in the portion of Sanpoil that burned in the Northstar wildfire of 2015. This area was dropped from the Sanpoil project area. The other two watersheds, Thirteen Mile and Ninemile Creek are either entirely or mostly in the current Sanpoil project area. Many of the EMDS findings were similar to those found by the Historical Range of Variability (HRV) and other analyses, and are briefly discussed in Section 3.

3.0 – Analysis Framework

3.1 - Purpose and Need

3.1.1 – Desired and existing conditions

The following desired and existing conditions are identified for vegetation resources are summarized below. Desired conditions associated with the revised LMP may be presented here ver batim from the LMP, or summarized in a manner relevant to the Sanpoil project environmental effects analysis.

FW-DC-VEG-01. Plant Species Composition

Native species and native plant communities are the desired dominant vegetation. National Forest System lands contribute to the diversity, species composition, and structural diversity of native upland plant communities. The full range of potential natural vegetation is maintained on the Forest where it supports plant and animal diversity including pollinators and other invertebrates, and robust ecological function.

FW-DC-VEG-02. Insects and Diseases

Native insects, diseases, fungi, bacteria, and viruses engage in their natural (endemic) role in contributing to ecosystem processes such as pollination, food webs, decay and nutrient cycling, providing habitats, and functioning as natural control agents. Landscapes provide a patchwork of varied structural, compositional, and successional stages that ensure the continuation of these processes.

FW-DC-VEG-03. Forest Structure

Desired forest structural classes are considered resilient at a variety of spatiotemporal scales and compatible with maintaining characteristic disturbance processes such as wildland fire, insects, and diseases. Structural classes were defined and mapped for the Colville National Forest based on LiDAR-derived attributes described in Table 1. Table 2 describes the desired proportion of each structural class for vegetation types found on the Colville National Forest, and Table 3 indicates expected patch size by forest vegetation type for vegetation types present within the project area. For the Sanpoil project, forest openings would generally range from 0-3 acres in size, commensurate with patch size and historical conditions for size and distribution reflecting natural disturbance processes and desired conditions described in the Forest Plan and Table 3.

Table 1. Structural class definitions for the Colville National Forest. Mapped tree sizes reflect the modeled 75th-percentile QMD for each pixel in the LiDAR-derived GIS. Canopy cover values were also calculated in a GIS from LiDAR-derived models and ground-based plots.

Class	Structure	Definition
1	Early	Trees less than 10” dbh or canopy cover < 10%
2	Mid Open	Trees 10-20” dbh, canopy cover ≥ 10% and < 40%
3	Mid Closed	Trees 10-20” dbh, canopy cover ≥ 40%
4	Late Open	Trees ≥ 20” dbh, canopy cover ≥ 10% and < 40%
5	Late Closed	Trees ≥ 20” dbh, canopy cover ≥ 40%

Table 2. Desired conditions for the relative extent of forest structure (HRV)* and vegetation types. Listed ranges are expressed as percentages of the total applicable vegetation type within a watershed.

	Early	Mid open	Mid closed	Late open	Late closed
Douglas-fir dry	6−16	2−8	4−13	38−78	1−32
Northern Rocky Mountain mixed conifer	9−25	1−3	18−30	4−6	44−60
Western hemlock / Western red cedar	4−24	0	7−27	0	55−83
Subalpine fir / Lodgepole pine	45−65	0	33−53	0	3
Spruce / Subalpine fir	14−46	0	13−41	0	29−57

* ST-Sim state and transition model software was used to provide values for the historical range of variability (HRV)

Table 3. Expected patch size by forest vegetation type for vegetation types present within the project area.

Vegetation type	Patch size	Opening size	Description
Douglas-fir dry	Highly variable	Primarily small (less than 5 acres) with occasional openings greater than 10 acres in very limited circumstances. Openings less than 40 acres in nearly all cases.	Larger patches of open-canopied stands would have included tree clumps and openings at a scale finer than that of an individual stand.
Northern Rocky Mountain Mixed Conifer	Variable (5 to 1,000 acres)	Openings generally less than 40 acres in size, with the majority of patches being less than 5 acres in size.	Mixed severity fire generates variable patches and openings, though most openings in this type would have historically been relatively small.
Subalpine fir / Lodgepole pine	Variable, ranging up to 1,000s of acres	Highly variable, with many small-medium patches (less than 40 acres) and a few larger patches up to 1,000 acres or more in size.	Predominantly smaller patches would have been interspersed with few, larger patches. The larger patches were historically created during extreme fire weather events much as they are today.
Spruce / Subalpine fir	Generally less than 500 acres, with the majority of patches less than 40 acres	Generally commensurate with patch sizes.	Both patch and opening size is primarily limited by spatial arrangement on the Colville National Forest. As a result, smaller patches and openings would occur here than is typical for this vegetation type.

FW-DC-RFP-01. Commercial Products

Provide a sustainable level of timber products for current and future generations. Production of timber from National Forest System lands contributes to an economically viable forest products industry and regularly meets

the average decadal allowable sale quantity. The Allowable Sale Quantity (ASQ) is 67 MMBF and the Long Term Sustained Yield (LTSY) is 97.4 MMBF16.

FW-DC-RFP-02. Products Available

A variety of renewable forest products of social, spiritual, and economic value are reasonably available to the public. Special forest products and merchantable timber products are ecosystem services provided to contribute to economic sustainability, social desires, or cultural needs.

General descriptions of existing vegetation conditions in the project area are provided here; Section 5.1 includes more detailed assessments for the specific forest vegetation resource issues analyzed for the Sanpoil project.

Desired condition for forest structure

The extent of forest structural stages (Churchill et al. 2016) were assessed across the Sanpoil project area in terms of the proportion of respective vegetation types and compared to desired ranges established for the Colville National Forest (USDA Forest Service 2019). Over-represented structural classes that exceed desired ranges are indicated in light shading, and under-represented classes are indicated in darker shading. Only 58 acres of the Northern Rocky Mountain mixed conifer vegetation type occurs within the Sanpoil project area, which is not enough for a credible analysis of structural stages at the watershed scale. The full complement of structural stages under a functional disturbance regime would not be expected to occur at such a small scale.

Table 4 indicates that there is currently too much mid open and mid closed forest structure classes in all forest vegetation groups, too much late open structure in the Spruce / subalpine fir vegetation group, and too much late closed in the subalpine fir / lodgepole pine type. Table 4 also shows that there is too little late open structure in the Douglas-fir dry vegetation type, and too little late closed in the spruce / subalpine fir vegetation type.

Structural conditions across forest vegetation types in the Sanpoil project area reflect a complex history of fire suppression, vegetation growth and succession, as well as periodic disturbances including timber harvests, and tree germination/infilling. The preponderance of mid open, mid closed and late closed structures, and the relative scarcity of early and late open structures generally arise from a lack of disturbance coupled with vegetation growth and conifer encroachment in what would have historically been non-forest vegetation communities. Early, open, and/or late structures that fall within desired ranges are mainly the result of past fire, harvest, and/or insect disturbances.

The mapped vegetation types and structural stages appears to under-represent the amount of non-forest vegetation types (grassland and non-forest savannah), resulting in a slight misclassification and overestimation of the early forest structural class, particularly in the Douglas-fir dry vegetation type. Mapped early structures also occur due to an unusually high amount of forest/meadow edge in the project area, in combination with fire exclusion and conifer in-filling. Prior to the fire suppression era, what is now classified as early forest structure would have likely persisted as non-forest, and what is now classified as mid open structure would have likely been classified as non-forest or early structure. The extent to which this may be true, however, is uncertain and existing conditions as mapped by Henderson (2012) and Churchill et al. (2016) are considered to be the best available scientific information for environmental analysis.

Table 4. Proportion of structure classes for five vegetation types in the Sanpoil project area. Over-represented structural classes that currently exceed desired ranges are indicated in light shading, and under-represented classes are indicated in darker shading.

StructureClass	Non-Forest	Douglas-fir dry	Spruce / Subalpine fir	Subalpine Fir/ Lodgepole pine	All forest veg. types

Non-forest	100%				
Early		14%	39%	17%	16%
Mid open		22%	12%	7%	19%
Mid closed	N/A	47%	44%	60%	49%
Late open		2%	1%	0%	2%
Late closed		15%	4%	15%	14%

Climate change

Projected climate changes, based on current knowledge, information, and data presents complex challenges in predicting long-term changes. Broad-scale climate change assumptions and potential effects were considered when writing the desired conditions for this plan, including:

- Continued warming in the Pacific Northwest is likely to result in increased water use by vegetation;
- Reduced water available for forest vegetation, wildlife, and humans;
- Increased mortality from insects, disease, and wildfire disturbances.

Insects, Pathogens, and Dwarf Mistletoes

Forest vegetation in the project area currently exhibits variable susceptibility to damage and/or mortality caused by native and non-native insects, pathogenic fungi, and dwarf mistletoes. Susceptibility is related to vegetation density, species composition, and vertical structure (Schmitt 1999, Schmitt and Powell 2005, Schmitt and Scott 1993; Scott 1996), and is also exacerbated by environmental stresses (Kolb et al. 2016).

Native insects, pathogens, and mistletoes are a natural part of a functioning forest ecosystem; however, impacts can be exacerbated when stands are overstocked and/or stand structures or species composition favor the disturbance agents. Wildfire exclusion, historic grazing practices, and historic timber harvesting are principal activities that have enabled increased live tree stocking levels, increased levels of mid and late seral species, and homogenization of spatial patterns. These factors contribute to conditions that support larger scale and more persistent insect outbreaks (Hessburg et al. 1994). These factors also lead to stand conditions that cause an increase of tree growth loss and mortality by native root diseases and dwarf mistletoes.

Increased tree density, stand structures and species compositions that favor root disease and dwarf mistletoe spread, increased insect levels of both defoliators and bark beetles, increased fuel levels, and climate change impacts such as water stress are all interacting factors influencing the levels of current late forest structures and will continue to influence future late forest structure development.

Forest health has been a concern in the project area for a number of years. Past harvests include salvage that emphasized removal of dwarf mistletoe and bark beetle infected individuals and altering stands to improve resistance to mountain pine beetle, root rot, spruce budworm and other pathogens. In an assessment of the insect and disease situation of the Sanpoil planning area, Mehmel (2017) found 11 different agents impacting the area. These were brooming diseases including various Douglas-fir, larch and lodgepole dwarf mistletoes, spruce broom rust, and elytroderma on the ponderosa pine; foliage insect and diseases, including spruce budworm, larch and lodgepole pine needle blights; western and mountain pine, western balsam and Douglas-fir bark beetles; and armillaria root rot.

Ecological Resilience

The Forest Service Manual defines resilience as the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change (FSM 2000 Chapter 2020.5).

In their paper "Basic principles of forest fuels reduction treatments" Agee and Skinner define resiliency as a forest capable of maintaining substantial live basal area after being burned by a wildfire (2005). Fitzgerald defines fire-resiliency as the ability of ponderosa pine forests to survive wildfires relatively intact, as typically occurred during pre-settlement times (2005).

In the context of this site-specific project, resiliency is considered *the ability of a forested area to survive a disturbance event, specifically wildfire and insect attack, relatively intact and without large scale tree mortality.* By using the term "relatively intact," this recognizes that the intent of the proposed treatments is not to fire-proof the area, but to set the area on a trajectory to where natural processes such as fire and insects can play a role in the system without causing large scale mortality. Currently, in many locations within the project area there is a high likelihood that expected disturbances would exhibit uncharacteristically high levels of severity and limit the capacity for vegetation recovery.

Forest Product availability and employment

Currently within the project area, timber forest products are not reasonably available to the public because they are not authorized for sale, cutting, or removal. The purpose of the Sanpoil project includes the authorization and provision of products that are economically viable and sustainable to support infrastructure and jobs in the tri-county area in northeast Washington State.

The Sanpoil project is located in western Ferry County, an area recently impacted by the closing of a large gold mine and subsequent layoffs of many residences. Ferry County in particular—as well as the rest of the tri-county area—have incomes below, and household poverty rates above those found in Washington State and the US as a whole. The economies of the three counties are natural resources based and timber production plays an integral role in economic health. The following table shows income and poverty rates measured against the State and USA as a whole. Information was taken from the US Census Bureau website (www.census.gov/quickfacts, facts tab) for the most recent year, 2016.

Table 5. Comparison of Economics for Tri-county from Census Data

	Ferry County	Stevens County	Pend Oreille County	Washington State	USA
Med. Household income	$39,555	$44,115	$46,036	$62,848	$55,322
Poverty rate	21.3%	14.3%	16.2%	11.35%	12.7%

3.1.3 - Purpose and need summary

The need for the Sanpoil project derives from apparent differences between existing and desired conditions now and in the foreseeable future. Such differences can be summarized as follows for forest vegetation in the project area:

- The full range of potential natural vegetation species composition and robust ecological function is threatened in the project area due to the risk of disturbances with uncharacteristically severe and extensive fire effects.

- Native insects, diseases, fungi, bacteria, and viruses are not engaging in natural (endemic) roles in contributing to ecosystem processes such as pollination, food webs, decay and nutrient cycling, providing habitats, and functioning as natural control agents. Instead, some of these disturbances—such as bark beetles—currently threaten to increase to epidemic, undesired levels.

- Forest structural classes are not resilient and compatible with maintaining characteristic disturbance processes such as wildland fire, insects, and diseases. Instead, the probability of uncharacteristic processes is elevated, as are risks to large, old individual trees and late open or late closed forest structures.

- The project landscape is dominated by too many areas with a high susceptibility to undesired uncharacteristic fire effects, posing risks to key ecosystem structures, regenerative processes, and human resources.

The purpose of the project is to address the identified needs and allow wildfire and native biotic damage agents to contribute to ecosystem processes at endemic levels, rather than threaten ecosystem processes at epidemic or catastrophic levels, specifically through the following modifications to vegetation and fuels:

- Alter tree species composition in favor of fire, drought, and disease-tolerant species such as ponderosa pine, western larch, and hardwoods such as birch, cottonwood, willow, and aspen;

- Lower forest density and allow greater light, water, and nutrient resources to be allocated across remaining trees;

- Maintain or create spatial patterns containing an appropriate mix of individuals, clumps, and small openings, thereby contributing to compositional diversity and a mix of possible habitats;

- Increase the extent of single-stratum vertical structures; and

- Where possible, increase size of forest structural patches.

3.2 - Other Resource Concerns and Opportunities

3.2.1 Aspen Treatments

Aspen has been identified as a desirable habitat for the Colville National Forest (FW-GDL-WL-03). While aspen are becoming increasingly valued across the west for visuals and habitat, stands are diminishing due to fire exclusion, competition for growing resources by conifers, and grazing, especially from deer and elk (Stringer, 2010; Hadfield and Magelssen, 2004). There are aspen stands within treatment units in the planning area. The majority of these stands are less than 1 acre in size. This is similar to aspen areas found elsewhere in eastern Washington (Hadfield and Magelssen, 2004). Hadfield and Magelssen recommend the following cultural treatments be undertaken to restore and maintain aspen:

- Remove competing conifers;
- Regenerate stands by cutting or killing the stems with fire (this promotes sprouting); and
- Protect stands from severe browsing.

3.4 – Issues, Indicators and Measures

Issues for the project were identified for detailed analysis following scoping. Issues are analyzed to describe possible environmental effects, determine consistency to relevant to laws, rules, and regulations, and to allow comparison between management alternatives with respect to the project purpose and need. All issues pertinent

to forest vegetation are described in this report as a cause-effect relationship, wherein the activities are considered in terms of their possible direct, indirect, and cumulative effects on forest vegetation.

The issues approved for analysis for the project are analyzed in terms of measures and indicators that describe the magnitude, spatial and temporal extent, likelihood, and speed of effects (Table 6). These measures and indicators enable four important elements of environmental planning: comparison of effects between alternatives, disclosure of possible effects to the general public, identification of possible measures to mitigate for or reduce undesired outcomes, and a reasoned decision. Most measures and indicators utilized for this report are quantitative, except for likelihood, which is not feasible to quantify with a reasonable degree of accuracy or an estimated error. For such cases, project effects on certain measures and indicators will be considered in qualitative terms using professional judgement.

Table 6. Issues, Measures, and Indicators used in the Sanpoil project environmental effects analysis for forest vegetation.

Issue	**Measures / Indicators**				
The proposed activities, in whole or in part, may:	**Magnitude**	**Speed**	**Spatial Extent**	**Temporal Extent / Duration**	**Likelihood**
Alter the distribution of forest structure classes across the project area	Allocation of classes within each forest vegetation type, relative to desired conditions.	Time (years) between project decision and completion of activities	Geographic area (acres)	Number of years between activity completion and reasonably foreseeable future	Near-certain / Likely / Uncertain / Not likely / Highly unlikely
Reduce susceptibility of forest vegetation to attack by root disease, defoliating insects, dwarf mistletoe, and bark beetles	Shift in susceptibility ratings[1]				
Reduce meadow encroachment by conifers	Percent reduction of conifers <100 years old in identified meadows				
Increase the extent and vigor of quaking aspen	Percent increase of aspen stocking and growth				
Create employment opportunities	Number of jobs associated with management activities.		Geographic area associated with forestry-sector jobs created by project		

4.0- Methodology

The methodology used to assess and disclose the existing conditions, and direct, indirect, and cumulative effects of the activities included under the project action alternative incorporated a variety of information sources. Any particular assessment method is associated with a set of both strengths (accuracy and precision) and weaknesses (uncertainty and error). This analysis of effects on forest vegetation resources strives for assessment and analytical strength through multiple lines of evidence (Goetz et al. 2012). The various methods utilized for this report are described in detail below, along with their associated strengths and weaknesses. The methods are characterized in terms relevant to successful implementation of the National Environmental Policy Act and

[1] Desired Schmitt and Powell (2005)

associated case law, which require or recommend that disclosure of environmental effects include consideration and discussion of data validation and error, use of methods standard in the practice a field relevant to the resource being considered (in this case, forestry), and incomplete and/or unavailable information.

Data Sources and Consideration of Best Available Science

The analysis information provided in this report was based on a variety of methodologies, models, and procedures, all of which are derived from scientific sources included in the references cited section. Many of the analytical processes were based on local protocols and documentation for them is also included in the references cited section.

- **Intensive Stand examinations**
- **Field reconnaissance**
- **Historical and scientific documents**
- **Professional expertise**
- **Aerial photogrammetry**

Spatial and Temporal Context for Effects Analysis

Spatial Context

The Sanpoil forest vegetation analysis area is defined in this report as all Colville National Forest lands classified as forest vegetation types (LMP, p.33) within the project area.

Temporal Context

Direct effects of implementing activities under any action alternative of the project were assumed to occur between the years 2020 and 2030—the anticipated timeframe for activity implementation. Indirect effects are estimated for 10-30 years into the future because that is a timeframe in which changes in structure, species composition, and density are expected to remain measurable and predictable with a reasonable degree of certainty. Beyond that timeframe, the moderate to high possibility of biophysical disturbances (insect outbreaks, wildfires, wind events, etc.) renders estimation of indirect effects highly speculative.

In addition to non-anthropogenic disturbances, existing conditions reflect vegetation changes resulting from activities described in the cumulative effects section of this report. The temporal bounding of past effects is the era when vegetation management and fire suppression began in the project vicinity—approximately 1900.

Present (ongoing) actions and reasonably foreseeable future actions were considered. Reasonably foreseeable future activities are defined as those activities which are planned to occur after the year 2016 and for which a decision has been made, or is listed on the Colville National Forest Schedule of Proposed Actions (SOPA).

5.0 - Environmental Consequences

Direct and Indirect effects

Alternative 1 – No Action

In the absence of significant disturbances, and given past, present, and reasonably foreseeable future activities in the context of climate change and future vegetation growth, it is likely that mid closed and late closed structures would continue to dominate the landscape and exceed desired ranges, while early and/or open structures would remain under-represented. Disturbances that do occur would likely remove the largest and most desirable Douglas-fir, lodgepole pine, and ponderosa pine from many stands, and/or result in patches of high-severity, high-intensity wildfire than are inconsistent with desired patterns or conditions.

No active management would take place in this alternative. This alternative would not reduce tree stocking or improve individual tree vigor and resistance to insect and disease attack. Forests with frequent and mixed-severity fire regimes would remain susceptible to uncharacteristically high-severity wildfire. There would be no precommercial nor commercial thinning to release stands for quickly achieving late structure. Aspen stands and open meadows in the project area would continue to experience conifer encroachment and diminish in size and/or vigor.

Stand densities and resulting tree competition would continue to increase throughout the area. As densities increase, growth and vigor would continue to decline, and extensive mortality would continue to occur as trees become stressed. In addition, stress caused by excessive density would increase susceptibility to injury and mortality caused by insect and disease. Stands historically dominated by low-severity disturbance regimes would continue to develop multi-storied vertical structures, increasing susceptibility to high-severity fire, pathogen, mistletoe, and/or defoliation disturbances. Large trees would continue to diminish in number as they are killed by bark beetles and/or high-severity fire. Late open forest structures would also diminish as a result of infilling by shade-tolerant species

Under this alternative, some potentially negative environmental effects would be avoided. For example, there will be no mechanical or prescribed burn caused scarring of the residual stand. No loss of site productivity due to soil compaction or loss of organic matter due to vegetation and fuels treatments would occur. No mortality of large trees due to prescribed fire or secondary agents following prescribed fire would occur. No economic gains would be created in this alternative

Alternative 2 – Proposed Action

Unit treatments and locations in this alternative were designed to meet the purpose and need of the project, promoting the capacity of forest vegetation and related ecosystem functions in the project area to resist and/or recover from fire and insect disturbances, move distributions of structural classes closer to desired ranges, and provide forest products that are economically viable and sustainable to support infrastructure and jobs in the tri-county area. The geographic extent of planned activities for the Sanpoil project is approximately 11,000 acres for tree-cutting activities and related slash treatment, and approximately 7,000 acres of underburning only.

This alternative utilizes commercial thinning harvests, precommercial thinning, fuels treatments and prescribed burns to modify species composition, stand structure and density with the intent of achieving the purpose and need. Tree-cutting and burning activities would aim to increase stand vigor and growth, reduce the potential for undesirable wildfire effects and insect and disease attacks, and move toward desired distributions of structural classes by treating stands, primarily in the Douglas-fir dry (85% of analysis area) and Subalpine fir / lodgepole pine (14%) forest vegetation types. An analysis of the magnitude, speed, spatial extent, duration, and likelihood of direct and indirect effects for each analyzed issue is presented in Table 7.

Susceptibility to disturbance and ecological resilience

Treatments would be designed and implemented to reduce stand density, canopy layering, and the preponderance of Douglas-fir and subalpine fir, all of which would generally reduce conditions favorable to forest insects, promote individual tree growth and resistance to biotic (diseases and mistletoes) and abiotic (drought) stressors. Consistent with the simplified stand-level susceptibility ratings for insects, pathogens, and dwarf mistletoes have been developed by Schmitt and Powell (2005), project silvicultural prescriptions would be designed to move stand-level susceptibility from "High" levels to "Moderate" or "Low" levels, and "Moderate" levels to "Low" levels. Silvicultural prescriptions for stands with existing "Low" levels of susceptibility would be developed to create or maintain conditions consistent with management objectives unrelated to insect, disease, or mistletoe susceptibility. These effects would occur across approximately 12,000 forested acres within the project area, mostly as a result of silvicultural tree-cutting activities. Shifts in density, species composition, and canopy layering resulting as a result of only underburning are highly uncertain across space and time. Fire effects would be overwhelmingly negligible for stand-level susceptibility levels, but moderate or high-severity effects may occur in across up to 2,000 acres to a degree sufficient to alter susceptibility in complex and dynamic ways that tend to cancel each other out: effects that may harm physiological capacity for tree defenses would be roughly counteracted by long-term shifts in composition and density that tend to favor stand-level susceptibility. Direct and indirect effects are expected to ramp up over a 1-10-year period as activities commence, and last for up to 30 years before changes in forest condition from growth and ecological succession reduce indirect effects on susceptibility to negligible levels. Direct and indirect effects on structural conditions as described in the revised LMP are summarized in Section 7 of this report.

The proposed treatments would increase the resistance and resilience of forested lands (Fettig et al. 2007, Graham et al. 2010, Graham et al. 2004, Hessburg et al. 2019, Hessburg et al. 2016, Hessburg et al. 2015, Jain et al. 2012, Jain et al. 2008, Long et al. 2018, Long and DeRose 2014, Safford et al. 2012)

The treatments would:

- Reduce surface, ladder and crown fuel loading;
- Move density and species composition towards reference conditions, shifting species composition toward fire- and drought- tolerant species;
- Increase spatial and structural heterogeneity;
- Create fire refugia (Coop et al. 2019);
- Establish regeneration and patch diversity; and
- Reduce wildfire severity and crown fire (Kennedy et al. 2019), thereby preserving biological legacies key to post-fire recovery and protecting late structure from conversion to early structure.

The treatments in early and middle structure would improve the vigor and growth of trees in those stands, helping them to transition toward middle and late structure appropriate to the forest type.

The proposed treatments would improve fire management options by reducing fuels and hazards along strategic roads and ridgelines, improving access, improving the efficiency of fire line construction, and improving the penetration of retardant to surface fuels (Moghaddas and Craggs 2007). Recent treatments as part of the Kettle Face and East Wedge projects were used effectively for fire management of the Boyds, Renner and Horns Mountain fires. Improved fire management options increase the opportunities to use managed wildfire, when and where appropriate, to "increase landscape heterogeneity, improve resilience and provide a buffer against

subsequent fires and future bark beetle outbreaks" (Hessburg et al. 2019). Managed wildfire is one of the few viable tools available for restoring Inventoried Roadless Areas and areas that lack access. Additionally, managed wildfire can enhance movement toward desired conditions for vegetation structure in areas within treated areas (Hessburg et al. 2019).

Meadow encroachment and aspen enhancement

Finally, project activities would reduce or minimize meadow encroachment by conifers and enhance the extent and vigor of quaking aspen through conifer felling or burning over a period of approximately 10 years. A 50-100% reduction of conifers less than 100 years old is expected in delineated meadow areas—often characterized by mollisol soils. The extent to which this would occur is estimated to be on the order of 50-500 acres within the footprint of planned activities, but the exact extent or location of each meadow and aspen stand limited by a lack of current air photo and soil survey delineation at the time of project analysis. The duration of effect for conifer encroachment is expected to last as long as conifer seedlings and samplings are absent from meadows, which is expected to be 5 to 30 years, after which time conifer infilling and germination may result in a new cohort in meadow areas. Increases of aspen vigor and extent are expected to last at least 30 years, after which point it is possible, but not certain, that ecological succession would result in future competition from conifers, or that climate change may result in physiological stress sufficient to negate any benefits associated with Sanpoil project activities. A 10-50% increase in aspen density, stocking, and/or growth is expected based on professional experience with similar projects and project areas.

Employment and economic opportunity

For commercial harvest units, McKetta et al. (2016) found an average of 1.79 private-sector jobs created per million board-feet across the Tri-County area in northeast Washington. Assuming the Sanpoil project generates 50 million board-feet of timber volume sold over a 10-year period, that equates to approximately 90 private-sector jobs associated with the commercial forest products markets, and 10 public-sector employment opportunities. Non-commercial activities associated with the project would result in employment opportunities for approximately 20-40 private-sector workers and 5 federal workers on a seasonal (part-time) basis over a 10-year period.

Alternative 2 proposes a variety of service contracts, roadwork, and harvests acres of timber. According to McKetta, et al. (2016) in a paper written in response to CFRLP monitoring questions, the bulk of these jobs will go out of the area. Jobs created in the economic zone of Ferry, Stevens, and Pend Oreille Counties and associated benefits will go primarily to Stevens County (about 73%), with 18% staying in Ferry County. However, the paper argues, the smaller economy of Ferry County, especially western Ferry County, which is geographically isolated from the more diverse economies of Eastern Ferry and Stevens Counties, makes the addition of each job in western Ferry County more critical. The paper found that of the activities proposed in the Sanpoil project, forest products (logs, chips and poles) are expected to produce the majority of the jobs and income associated with activities. While many of the jobs would actually be absorbed by people already working in the industry as additional hours, some new positions may be created.

Table 7. Direct and indirect effects for issues, measures, and indicators utilized for the Sanpoil project environmental effects analysis for forest vegetation.

Issue *The proposed activities, in whole or in part, may:*	Measures / Indicators				
	Magnitude *(amount of change of a value)*	**Speed**	**Spatial Extent**	**Temporal Extent / Duration**	**Likelihood**
Alter the distribution of forest structure classes across the project area	Combination of movements either neutral or favorable with respect to desired conditions. Summarized in Section 7 of this report.	1-10 years	Approximately 10,000 forested acres	10-30 years	Likely
Alter susceptibility of forest vegetation to attack by root disease, defoliating insects, dwarf mistletoe, and bark beetles.	Reduction of stand-level susceptibility from High to Moderate or Low, and/or Moderate to Low.	1-10 years		1-30 years	Likely for tree-cutting units; uncertain for areas with only underburning
Reduce meadow encroachment by conifers	50-100% reduction of conifers <100 years old in delineated meadows.	1-10 years	50-500 acres	5-30 years	Likely
Increase the extent and vigor of quaking aspen.	10-50% increase of aspen density, extent, and/or growth	10-30 years	50-500 acres	10-30 years	Likely
Create employment opportunities	Up to 100 full-time and 25-45 part-time (seasonal) employment opportunities.	1-10 years	Oregon, Washington, and Idaho	1-10 years	Near-certain

Structure class distribution

Approximately 78 percent of the forested land in the planning area (approximately 37,000 acres) needs some kind of modification of structural class to move all vegetation types and structural classes within desired ranges described in Table 5 of the Colville National Forest LMP. Silvicultural activities are proposed on just under 40 percent of federal forested lands in the project area. The amount and intensity of treatment proposed was constrained by designations in the revised LMP and accessibility/operability. These conditions constrain the benefits of restoration treatments (Lydersen et al. 2019) and increase the time horizon for restoration.

The proposed activities would trend forest structural classes toward compatibility with maintaining characteristic disturbance process such as wildland fire, insects and disease, and storms over the short and long-term. Due to existing species composition in the seed bank and the length of time for desired species to reach reproductive ages, it may take up 100 years or more of restoration treatments and managed wildfires to restore conditions (Pass 2004, Carroll et al. 2007). Approximately 85 percent of the proposed treatments fall within the Douglas-fir dry forest type. Activity effects relative to desired ranges for Northern Rocky Mountain Mixed Conifer (NRMMC) vegetation type are not reported because the extent of this vegetation type is only 58 acres within the project area—too small for a full complement of structural classes to be expected or meaningful under characteristic disturbance regimes.

Effects reported in this section that would occur over a 30-year period are assumed to occur without the occurrence of a mixed or high-severity disturbance.

Table 8. Resource indicators and measures for the proposed action direct and indirect effects on forest structure classes and vegetation types are shown below. Light grey shading where the proposed action moves structure class conditions away from HRV in the short-term. Medium grey shading indicates where the proposed action moves structure class conditions toward desired conditions but does not move it far enough to change it from above or below HRV. Dark shading indicates where the proposed action moves structure class to within HRV. An absence of shading indicates where the proposed action results in no change to the current structure class percentage, or condition above/below (indicated by an (a) or (b), respectively) desired ranges. All numeric values indicate percentages relative to the respective vegetation type.

Vegetation Type	Category	Structure Class				
		Early	Mid Open	Mid Closed	Late Open	Late Closed
Douglas-fir Dry 35,145 acres	Current	14	22 (a)	47 (a)	2 (b)	15
	Desired	6-16	2-8	4-13	38-78	1-32
	Post-treatment year 0	15	45 (a)	23 (a)	10 (b)	7
	Change	+1	+23	-24	+7	-8
Northern Rocky Mountain mixed conifer (NRMMC) 58 acres	Current	0	5	68	0	27
	Desired	N/A				
	Post-treatment year 0	0	12	61	0	27
	Change	0	+7	-7	0	0
Subalpine fir / Lodgepole pine 10,500 acres	Current	17 (b)	7 (a)	60 (a)	0	15 (a)
	Desired	45-65	0	33-53	0	3
	Post-treatment year 0	26 (b)	16 (a)	44	3 (a)	10 (a)
	Change	+9	+9	-16	+3	-5
Spruce / Subalpine fir 1,311 acres	Current	39	12 (a)	44	1 (a)	4 (b)
	Desired	14-46	0	13-41	0	29-57
	Post-treatment year 0	43	12 (a)	40	1 (a)	4 (b)
	Change	+5	0	-4	0	0

Early structure. There are about 1,800 acres of proposed treatments in early structure, accounting for about 10 percent of the project total treatments. The extent and allocation of silvicultural and fuels activity sequences occurring in this structure class are summarized in Table 9.

Proposed regeneration harvest treatments and underburning in vegetation types dominated by subalpine fir, lodgepole pine, and Engelmann spruce would move some mid and late structures to early structure, with the largest percentage movements in the subalpine fir / lodgepole pine and spruce / subalpine fir vegetation types.

Regeneration treatments would trend patch sizes towards the expected patch size by forest type, however treatments would not create the larger patches reflective of historic disturbances within the forest types that had large patch sizes historically.

Over the next 30 years: Early structure created by proposed regeneration harvests would be nearing mid structure, but most of it would still be early structure. Early structure that had a thinning treatment (ladder fuel reduction or precommercial thinning) would move to mid open and mid closed structure. Early structure that had no thinning would move to mid closed structure. As a result, Douglas-fir dry and subalpine fir / lodgepole pine types would likely be below desired ranges, while the spruce / subalpine fir type would likely remain within the desired range for the next 30 years.

Table 9. Activity sequence extent and proportion of vegetation structure stages for the Sanpoil project, for sequences constituting greater than 5% of a given structure stage.

Structure stage	Activity sequence	Acres	Percent of structure stage
Early	Commercial thin and machine pile burn	300	17%
	Precommercial thin	221	12%
	Precommercial thin and underburn	184	10%
	Shaded fuel break, hand-pile, and pile burn	108	6%
	Underburn only	760	42%
Mid closed	Commercial thin and machine pile burn	1,170	16%
	Commercial thin with openings, machine pile and pile burn	1,223	6%
	Precommercial thin	1,414	17%
	Shaded fuel break, hand-pile, and pile burn	1,306	14%
	Underburn only	3,674	32%
Mid open	Commercial thin and machine pile burn	597	22%
	Commercial thin with openings, machine pile and pile burn	187	8%
	Precommercial thin	464	12%
	Precommercial thin and underburn	210	39%
	Shaded fuel break, hand-pile, and pile burn	202	12%
	Underburn only	1,036	12%
Late open	Commercial thin and machine pile burn	86	14%
	Precommercial thin	33	13%
	Shaded fuel break, hand-pile, and pile burn	47	37%
	Underburn only	152	19%
Late closed	Commercial thin and machine pile burn	509	6%
	Commercial thin with openings, machine pile and pile burn	185	15%
	Precommercial thin	526	7%
	Shaded fuel break, hand-pile, and pile burn	442	6%
	Underburn only	1,004	33%

Mid open structure. There are about 3,000 acres of proposed treatments in mid open structure, accounting for about 18 percent of the project total treatments. The extent and allocation of silvicultural and fuels activity sequences occurring in this structure class are summarized in Table 9.

Commercial harvest, precommercial thinning (PCT), and ladder fuel reduction (LFR) treatments would move mid closed to mid open structure. Each forest type would show an increase in mid open structure. Treatments that move mid closed to mid open structure will increase resilience and tree vigor and provide options for growing the type of late structure (open or closed) appropriate to the forest type. Additionally, creating mid open structure from mid closed structure is the best pathway to resilient late open structure in the Douglas-fir dry and NRMMC forest types. Underburning treatments occurring in areas dominated by Englemann spruce, lodgepole pine, and/or subalpine fir have the potential to burn at high severity and enable a conversion to early structure.

Over the next 30 years: Untreated mid open structure would densify into mid closed structure and approach pre-treatment levels within 5-10 years in high-elevation and/or northerly aspects, and likely remain in a mid open

structure on southerly and/or low-elevation sites. Mid open structure created by treatments would densify into closed structure over a 20-30 year period. Mid open structure created by commercial treatments would grow into late structure in 20-30 years. Mid open structures are expected to remain fairly constant over the next 30 years as growing early structure forests grow into a mid open stage, and mid open stages density into mid closed stages or grow into late open or late closed stages. Mid open structures would likely remain above desired ranges for the Douglas-fir dry vegetation type, while the other vegetation types could transition either towards or away from desired ranges.

Mid closed structure. There are about 10,000 acres of proposed treatments in mid closed structure, accounting for about 54 percent of the project total treatments. The extent and allocation of silvicultural and fuels activity sequences occurring in this structure class are summarized in Table 9. Underburning treatments occurring in areas dominated by Englemann spruce, lodgepole pine, and/or subalpine fir have the potential to burn at high severity and enable a conversion to early structure. Activities occurring in mid closed structures would otherwise result in the conversion to mid open structures.

Over the next 30 years: Treated mid closed stands would remain in a mid open condition or transition in a manner described in the previous paragraphs. Untreated mid closed stands would experience increases in extent due to in-filling and density increases of mid open stands, concurrent with decreases in extent due to transitions to late closed stages. The net result of this combination is expected to be a stable or slightly increasing extent in the Douglas-fir dry vegetation type, because the mid open stage would be a substantially more prevalent than mid closed for this vegetation type at the outset of the analysis period. The opposite result is expected for the subalpine fir / lodgepole pine and Engelmann spruce / subalpine fir vegetation types.

Late open structure. There are about 390 acres of proposed treatment in late open structure, accounting for about 2 percent of the project total treatments. The extent and allocation of silvicultural and fuels activity sequences occurring in this structure class are summarized in Table 9. Underburning treatments occurring in areas dominated by Englemann spruce, lodgepole pine, and/or subalpine fir have the potential to burn at high severity and enable a conversion to early structure. Late open structure would move toward desired ranges for the Douglas-fir dry vegetation type, and slightly above desired value for the subalpine fir / lodgepole pine type.

Over the next 30 years: Late open stands in the subalpine fir / lodgepole pine type would likely transition to late closed due to rapid infilling and growth of tree regeneration over a 30-year period. Follow-up maintenance treatments may be needed within 15 to 30 years to maintain open structure within some Douglas-fir dry forests, while other areas would remain in a late open condition due to low overstory and regeneration density. Without additional disturbances, ate open stands for the Douglas-fir vegetation type would likely remain below desired ranges for at least 30 years following project implementation, while other vegetation types could transition either toward or away from desired levels of late open stages.

Late closed structure. There are about 3,200 acres of proposed treatment in late closed structure, accounting for about 18 percent of the project total treatments. The extent and allocation of silvicultural and fuels activity sequences occurring in this structure class are summarized in Table 9. Underburning treatments occurring in areas dominated by Englemann spruce, lodgepole pine, and/or subalpine fir have the potential to burn at high severity and enable a conversion to early structure.

Over the next 30 years: Treated late closed stands would remain in a late open condition or transition in a manner described in the previous for late open structure classes. Untreated late closed stands would experience increases in extent due to in-filling and density increases of mid closed and late open stands. The late closed structure stage is expected to remain within desired ranges for the Douglas-fir vegetation type, because it would begin the period at the low end of the range and the extent of mid closed and late open stands is not likely enough to move the extent above the desired range. The relatively large extent of mid closed structures in the

Engelmann spruce vegetation type make it likely that the minor extent of late closed will move upward, toward or within desired ranges over a 30-year period. For similar reasons, the extent of the subalpine fir / lodgepole pine type is expected to remain above desired ranges for the late closed structure stage.

Cumulative Effects: Alternative 2

The Sanpoil planning area includes a variety of past, present, and reasonably foreseeable future activities. These activities, and the relationship of their direct and indirect effects with the overlapping (in space and time) direct and indirect effects of the Sanpoil project, are described in Table 10 and Figure 3.

The cumulative effects of the Sanpoil project include the direct and indirect effects of the project activities themselves, in combination with the direct and indirect effects of all overlapping (in space and time) other past, present, and reasonably foreseeable future activities. The relationships of the Sanpoil proposed action and other activities with direct/indirect effects on forest vegetation that overlap in space and time are shown in Table 10.

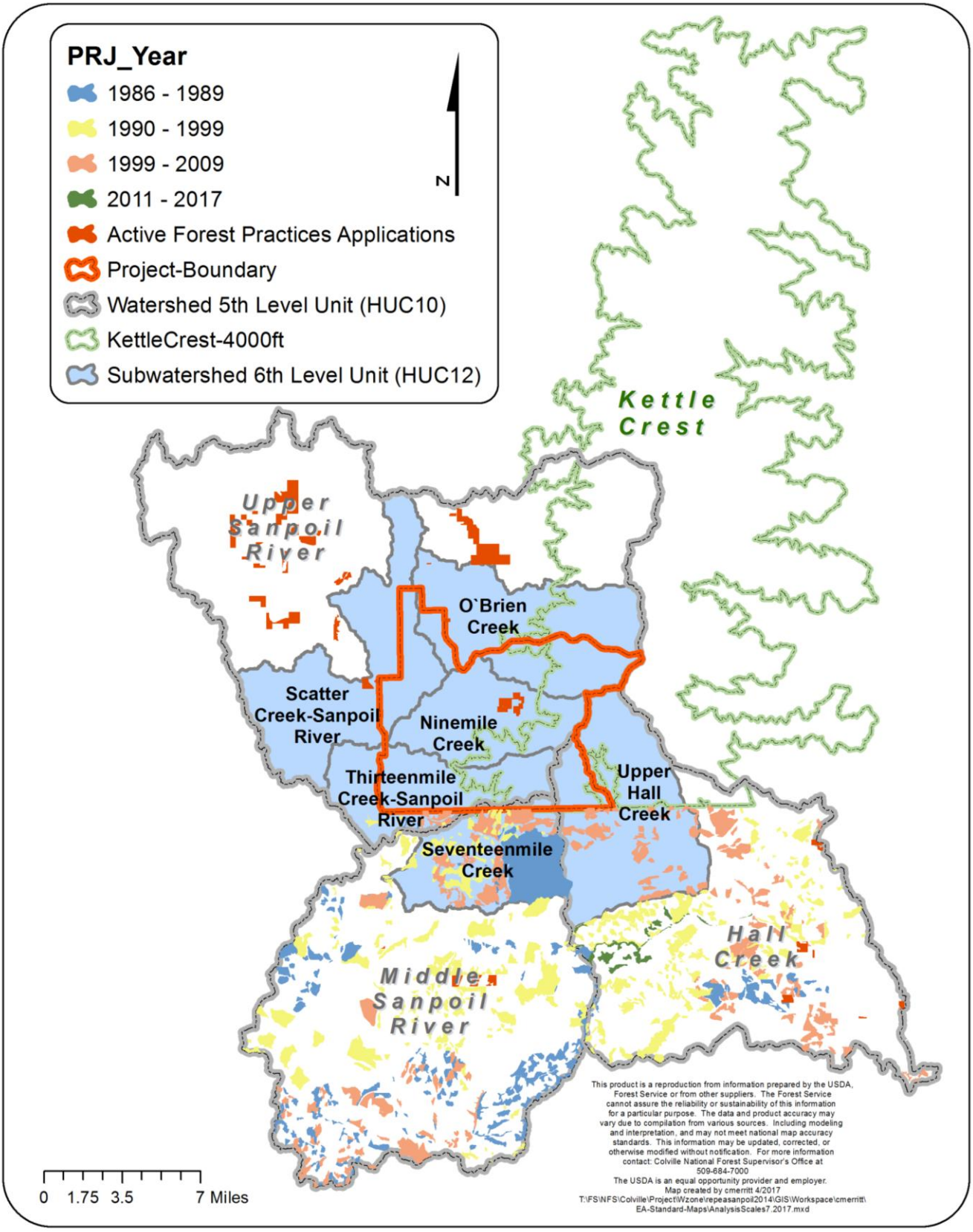

Figure 1. Watersheds, subwatersheds, and past activities in and around the Sanpoil project boundary.

Table 10. Past Actions that may contribute to Cumulative Effects

Past Actions	Timing	Description	Effects discussion and incremental impact of Sanpoil project
Fire suppression			
Fire suppression	Approximately 1900s to present	Containment and suppression of human and lightning-caused fires.	Contributing factor to continual and ongoing successional transitions: - Increasing density - Increasing amount of canopy layering - Increasing dominance of mid and late-seral, shade-tolerant tree species, to the detriment of early seral, shade-intolerant species, including quaking aspen and other hardwoods. - Meadow encroachment by conifers - Increased live and dead fuel loading. - Increased dominance of large fires and larger patches of high-severity fire effects. The incremental impact of the project on the environment is to provide a partial reversal of these profound and extensive changes, which are reflected in existing vegetation conditions. The degree to which the project is expected to do so is captured in the direct and indirect effects section.
Vegetation Management/Fuels Reduction Projects—Past Harvest			
Commercial Harvest	Note: listed treatments by decade are from the Forest Services' Activity Database (FACTS); additional treatments are known to have occurred, this is not mean to be an exhaustive list of every acre treated but rather an approximation of the types of treatments that led to the current conditions in the project area.		

Past Actions	Timing	Description	Effects discussion and incremental impact of Sanpoil project
	1950s	1,120 acres of commercial thinning, 3,290 acres of regeneration harvest 0 acres PCT	The incremental impact of the Sanpoil project on the environment when added to the impacts of these activities would be mixed for vegetation species composition, structure, and density. In come areas, the Sanpoil project will reverse or mitigate for the effects of these activities, while in others, the effects would be amplified or additive. Collectively, this mix of compensatory and additive effects would render the incremental impacts of the Sanpoil project negligible with respect to past commercial harvest activities.
	1960s	875 acres commercial thinning, 50 acres precommercial thinning (PCT), 3,056 acres regeneration harvest	
	1970s	1,520 acres commercial thinning, 4,700 acres precommercial thinning (PCT), 1,730 acres regeneration harvest	
	1980s	50 acres commercial thinning, 2,020 acres precommercial thinning (PCT), 3,260 acres regeneration harvest	
	1990s	1,960 acres commercial thinning, 1,790 acres precommercial thinning (PCT), 630 acres regeneration harvest	
	2000s	0 acres commercial thinning, 450 acres precommercial thinning (PCT), 0 acres regeneration harvest	
	2010s	400 acres commercial thinning, 0 acres precommercial thinning (PCT), 0 acres regeneration harvest	
Commercial thinning harvest **in the three watersheds** that overlap the Sanpoil Project Area	1980s	Treatments of all types occurring between 1980 and 1989, rough estimate based on interpreted data **9,385 acres treatment**	Harvest has either been completed or is planned for the decade listed. Most treatments occur south of the Sanpoil project area and very few treatments fall into the Upper Sanpoil River Watershed.
	1990s	Treatments of all types occurring between 1990 and 1999, rough estimate based on interpreted data	

Past Actions	Timing	Description	Effects discussion and incremental impact of Sanpoil project
		21,680 acres treatment	
	2000s	Treatments of all types occurring between 2000 and 2009, rough estimate based on interpreted data **16,733 acres treatment**	
	2010s	Treatments of all types occurring between 2010 and 2017, rough estimate based on interpreted data **991 acres treatment**	
Commercial Harvest on Private Land **in the three watersheds** that overlap the project area	July 2018 (estimated start of harvest) through December 2018	Active Forest Practices Applications in the three watersheds that overlap the project area (includes Upper Sanpoil, Middle Sanpoil, and Hall Creek Watersheds) Even-age harvest 132 acres Uneven-aged harvest 885 acres Salvage 152 acres	Harvest has been authorized by the DNR and may occur at any time during the application period. Cutting would be generally limited to smaller private holdings and could be either even aged or uneven aged harvest as noted. The incremental impact of the Sanpoil project on the environment when added to the impacts of these activities would be mixed for vegetation species composition, structure, and density. In some areas, the Sanpoil project will reverse or mitigate for the effects of these activities, while in others, the effects would be amplified or additive. Collectively, this mix of compensatory and additive effects would render the incremental impacts of the Sanpoil project negligible with respect to past commercial harvest activities.
	2019	Even-aged harvest 803 acres Uneven-aged harvest 87 acres	
	2020	Even-aged harvest 623 acres Uneven-aged harvest 1,629 acres	
	2024	Even-aged harvest 64 acres Uneven-aged harvest 401 acres	
	2026	Even-aged harvest 401 acres	
	2027	Uneven-aged harvest 317 acres	

Past Actions	Timing	Description	Effects discussion and incremental impact of Sanpoil project
Commercial Harvest on Private Land **in the project area**	2018-2020	Even-aged harvest 427 acres	Harvest has been authorized by the DNR and may occur at any time during the application period. Cutting would be generally limited to smaller private holdings and could be either even aged or uneven aged harvest as noted. The incremental impact of the Sanpoil project on the environment when added to the impacts of these activities would be mixed for vegetation species composition, structure, and density. In some areas, the Sanpoil project will reverse or mitigate for the effects of these activities, while in others, the effects would be amplified or additive. Collectively, this mix of compensatory and additive effects would render the incremental impacts of the Sanpoil project negligible with respect to past commercial harvest activities.

***Past activities listed here created current forest structure and associated wildlife habitat. These past activities can be considered in most cases as best analyzed by describing the current condition.**

Table 11. Ongoing or reasonably foreseeable future actions that may contribute to cumulative effects.

Project Name/Activity	Timing	Description	Predicted or Ongoing Effects
Vegetation Management/Fuels Reduction Projects			
Range			
Grazing	Present to reasonably foreseeable future	The Quartz allotment overlaps with the Sanpoil project area. Grazing is currently permitted for 328 cow/calf pairs.	Cows graze this pasture for a season of use between June and October 31. Allotment is managed under a three pasture deferred rotation grazing system.
Fire suppression	Present to reasonably foreseeable future	Containment and suppression of human and lightning-caused fires.	Contributing factor to continual and ongoing successional transitions: - Increasing density - Increasing amount of canopy layering - Increasing dominance of mid and late-seral, shade-tolerant tree species, to the detriment of early seral, shade-intolerant species, including quaking aspen and other hardwoods. - Meadow encroachment by conifers - Increased live and dead fuel loading. - Increased dominance of large fires and larger patches of high-severity fire effects. The incremental impact of the project on the environment is to provide a partial reversal of these profound and extensive changes, which are reflected in existing vegetation conditions. The degree to which the project is expected to do so is captured in the direct and indirect effects section.

6.0 – Summary of Environmental Consequences

The proposed action alternative would reduce conifer density, reduce canopy layering, and increase the relative abundance of disturbance and drought-tolerant species. This would improve individual tree vigor, tree resistance to insect and pathogen attack, and forest susceptibility to uncharacteristic high-severity wildfire. The project would enhance desired hardwoods and reduce recent conifer encroachment in meadows. The project would maintain or enhance ecosystem function by increasing vegetation capacity for resistance and resilience/recovery in the context of anticipated stressors and disturbances. The absolute and relative extent of these effects is approximately the extent of activities outlined above in Table 10.

The speed at which effects would occur is a 1-5-year period, lasting approximately 30-50 years or until the next measurable disturbance. The likelihood can be characterized as "near-certain" for the first few years following implementation, gradually diminishing with time over the next several decades. The spatial extent of these effects falls within the extent of the planning area. Associated activities within the project area would occur from approximately 2020 to 2025. The past regeneration harvests in the planning area were reforested with the expectation of follow-up treatments to include precommercial thinning or commercial harvest in order to maintain forest health and HRV goals.

The proposed action will also create jobs adding economic benefit through service contracts, roadwork, and harvest acres of timber to local and surrounding areas. The majority of economic benefit will be seen due to forest products.

7.0 - Compliance with the NFMA and Other Relevant Laws, Regulations, Policies and Plans

The proposed action has been reviewed and is determined to be in compliance and consistent with the laws, regulations, policies and LMP direction as discussed in Section 2 and applicable to forest vegetation resources on the project planning area. This section provides a rationale for each consistency determination, or finding, made for relevant laws, regulations, policies, and plans.

The National Forest Management Act (NFMA; Public Law 94-588; 16 U.S.C. 1600) requires specific findings to be made and documented when considering the implementation of certain management practices on National Forest System lands—findings that demonstrate activity consistency with NFMA requirements. The basis and rationale for such consistency findings are described in this section. NFMA-related consistency findings are made with respect to the Colville National Forest Land and Resource Management Plan (36 CFR 219), as well as the appropriateness of even-aged management, the optimality of clearcutting, and other provisions for vegetation manipulation.

Colville LMP Management Direction Components

As described earlier in this report, an authorized project or activity must be consistent with all applicable LMP management direction components: desired conditions, objectives, guidelines, and/or standards. The suitability of National Forest System lands for various uses and management activities are identified in the LMP, including planned and unplanned ignitions, forest products and timber production. The Sanpoil project includes these activities and uses, as well as other activities such as non-commercial tree thinning or tree planting. Included activities must be categorized as "suitable" in the Forest Plan for the

Management Areas in which they occur, but other activities may be conducted if they contribute the desired conditions for their respective Management Area (36 CFR 219.7(e)(1); Forest Plan p.15).

The geographic extent of Sanpoil project activities and activity combinations is summarized in Table 12 for the project area and for individual management areas within the project area.

Table 12. Geographic extent of Sanpoil project activities and activity combinations, grouped by Forest Plan Management Area.

Management Areas and planned activities	Acres
Backcountry	**4257**
Underburn	3926
Precommercial thin	2
Hand-piling and pile-burning	2
Variable-density commercial thinning; Machine-pile and pile-burn	16
Commercial thinning with openings; Machine-pile and pile-burn	<1
Shelterwood cutting; Machine-pile and pile-burn	<1
Commercial thinning with openings; Machine-pile and pile-burn; tree planting	1
Shelterwood cutting; Machine-pile and pile-burn; underburning; tree planting	1
Shaded fuel break; hand-pile and pile-burn	118
Shaded fuel break; machine-pile and pile-burn	1
Shaded fuel break; hand or machine-pile and pile-burn	186
Commercial thin and shaded fuel break; hand or machine-pile and pile-burn	5
Focused Restoration	**194**
Shaded fuel break; hand or machine-pile and pile-burn	194
General Restoration	**13823**
Underburn	3452
Precommercial thin	2202
Precommercial thin and underburn	311
Hand-piling and pile-burning	8
Variable-density commercial thinning; Machine-pile and pile-burn	3764
Variable-density commercial thinning; Machine-pile and pile-burn; Underburn	214
Commercial thinning with openings; Machine-pile and pile-burn	811
Commercial thinning with openings; Machine-pile and pile-burn; Underburn	179
Shelterwood cutting; Machine-pile and pile-burn	176
Small-pine thinning; machine-pile and pile-burn	404
Small-pine thinning; machine-pile and pile-burn; underburn	120
Commercial thinning with openings; Machine-pile and pile-burn; tree planting	277
Shelterwood cutting; Machine-pile and pile-burn; tree planting	43
Shelterwood cutting; Machine-pile and pile-burn; underburning; tree planting	73
Ladder fuel reduction; machine-pile and pile burn	10
Ladder fuel reduction; machine-pile and pile burn; underburn	19
Shaded fuel break; hand-pile and pile-burn	320
Shaded fuel break; machine-pile and pile-burn	1111

Shaded fuel break; machine-pile and pile-burn; underburn	262
Shaded fuel break; hand or machine-pile and pile-burn	37
Commercial thin and shaded fuel break; hand or machine-pile and pile-burn	31
Scenic Byways	**10**
Underburn	4
Precommercial thin	6

Forest-wide components

Desired Conditions (goals)

FW-DC-VEG-01. Plant Species Composition. The Sanpoil project activities are expected to maintain native species and native plant communities as the dominant vegetation because they would not fundamentally diminish the primary productivity of the growing sites, the availability of native species propagules. Introductions of invasive species would be avoided and minimized through the implementation of project design criteria and early detection/rapid response treatments. National Forest System lands contribute to the compositional and structural diversity of native upland plant communities. The project is expected to maintain the full range of potential natural vegetation is maintained on the Forest where it supports plant and animal diversity including pollinators and other invertebrates, and robust ecological function.

FW-DC-VEG-02. Insects and Diseases. The Sanpoil project activities are not expected to eliminate food or habitat resources at the sub-watershed or watershed scale for native insects, diseases, fungi, bacteria, and viruses, and allow them to continue to engage in their natural (endemic) role in contributing to ecosystem processes such as pollination, food webs, decay and nutrient cycling, providing habitats, and functioning as natural control agents. The combination of treated/untreated areas and variable disturbance severity in the project area will allow the landscapes to provide a patchwork of varied structural, compositional, and successional stages that ensure the continuation of these processes.

FW-DC-VEG-03. Forest Structure. The Sanpoil project is expected to increase the abundance of forest structural classes—specifically, one or two-age structures of low or moderate variable-density—considered resilient and compatible with maintaining characteristic disturbance processes such as wildland fire, insects, and diseases. The project would generally result in the conversion of closed to open structure classes, the maintenance of open structure classes, and in limited cases, result in the creation of early structure classes in the Douglas-fir Dry vegetation type. Over time, barring high-severity disturbances, open structures would convert to late open or late closed structure classes. Given the conditions described in Table 4, this would generally result in three possible outcomes, depending on the location, activity, structure class, and vegetation type in question:

1) The project would be neutral with regard to progress toward plan desired conditions, because areas of one over-represented structure class (mid closed) would simply be converted to acres of another over-represented structure class (mid open) in the short term;

2) Maintain or make progress toward one or more of the desired conditions over the long term, even if the project or activity would adversely affect progress toward or maintenance of one or more desired conditions in the short term. This be primarily true in Douglas-fir dry forests where late closed structures are converted to late open structures via thinning (desired) over the long term, but late closed structures are converted to late open structures over the short term in Spruce / subalpine fir vegetation types.

3) Maintain or make progress toward one or more of the desired conditions over the long term, even if the project or activity would adversely affect progress toward other desired conditions in a negligible way over the long term. This is true for the Sanpoil project because progress is made toward creating desired early and late open structures over the long run in Subalpine fir / Lodgepole pine and Douglas fir dry vegetation types (respectively) despite negligible adverse effects on progress over the long run in limited areas such as the conversion toward late structures in Subalpine fir / Lodgepole pine.

Forest openings resulting from the project would be commensurate with patch size and historical conditions for size and distribution reflecting natural disturbance processes and desired conditions described in the Forest Plan. Historical range of variability were evaluated on National Forest System lands at the appropriate scale, given vegetation type and natural disturbance history.

FW-DC-VEG-05. Biological Legacies. Sanpoil project silvicultural prescriptions would favor the retention of abundant large trees, snags, and down wood across the landscape. Large tree habitat would be maintained to support wildlife, aquatic and soil resources and support recovery processes in the post disturbance ecosystem.

Examples of biological legacy categories are provided in Table 9 of the Forest Plan. Not all components will be present within an individual site-specific project area.

Objectives

FW-OBJ-VEG-01. Restoration. The Sanpoil project is a component of efforts and objectives to initiate active management activities on 18,000 to 25,000 acres per year over the next 15 years to move structure toward desired conditions at landscape scales to move the Forest toward desired vegetative conditions and have landscapes dominated by Fire Regime Condition Class I, with the remainder in Fire Regime Condition Class II trending toward Fire Regime Condition Class I.[2]

FW-OBJ-VEG-02. Fuels Treatments. The Sanpoil project is a component of efforts and objectives to initiate fuel reduction activities on 5,000 acres per year over the next 15 years to reduce hazardous fuel accumulations in both activity and natural fuels to move toward desired vegetative conditions and have landscapes dominated by Fire Regime Condition Class I.

Standards

FW-STD-VEG-03. Timber Production. Regulated timber harvest activities would occur only on those lands classified as suitable for timber production (see suitability tables in Chapter 3 of the Forest Plan). Timber harvest on lands not suitable for timber production would occur only to meet multiple-use purposes other than timber production.

FW-STD-VEG-04. Even-Aged Harvest Openings. No individual harvest openings created by even-aged silvicultural practices are proposed that would exceed 40 acres. These opening size limits shall not apply to the size of areas harvested as a result of natural catastrophic conditions such as fire, insect and disease attack, or windstorm.

FW-STD-VEG-05. Restocking. All project activity locations that include the harvest of timber from National Forest System would be adequately restocked within 5 years after harvest.

---

[2] Condition class in this context includes more than just forest structure and density, rather, it also includes ecological legacy considerations shown in Table 9 such as species composition, insect and disease pathogen conditions, invasive species impacts, and other understory and overstory influences.

FW-STD-VEG-06. Even-aged Management. There are no activities planned as part of the Sanpoil project that include a shelterwood establishment cut, seed-tree seed cut, or clearcut harvest of even-aged stands on lands identified as suitable for timber production where timber production is the primary purpose for the harvest. This standard is not applicable to the use of sound silvicultural practices, such as thinning or other stand improvement measures, or salvage or sanitation harvesting of timber stands that are substantially damaged by fire, windthrow or other catastrophe, or that are in imminent danger from insect or disease attack.

FW-STD-VEG-07. Even-aged Management. Silvicultural prescriptions written for the project would ensure that any cutting activities designed to regenerate an even-aged stand of timber will be used as a cutting method on National Forest System lands only where for clearcutting, it is determined to be the optimum method, and for other such cuts it is determined to be appropriate to meet the objectives and requirements of the Forest Plan.

FW-STD-VEG-08. Harvest Systems. No harvesting system to be used as part of the Sanpoil project would be selected primarily because it will give the greatest dollar return or the greatest unit output of timber, although costs would be considered.

FW-STD-VEG-09. Timber Harvest. Timber is not expected to be harvested from National Forest System lands where soil, slope, or other watershed conditions would be irreversibly damaged and where protection is provided for streams, stream-banks, shorelines, lakes, wetlands, and other bodies of water from detrimental changes in water temperature, blockage of water courses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fish habitat.

Guidelines

FW-GDL-VEG-03. Large Tree Management. Sanpoil project activities would retain and generally emphasize recruitment of individual large trees (larger than 20 inches diameter at breast height) across the landscape, because silvicultural prescriptions would be implemented to reduce losses of large trees to disturbances, and would include a diameter limit of 21 inches DBH. If any trees larger than 20 inches DBH and less than 21 inches DBH are removed, it is because they would meet one of the following exceptions:

- Trees need to be removed for public health or safety (such as, but not limited to, danger/hazard trees along roads or in developed or administrative sites).
- The following exemptions apply only to situations where removal of smaller trees alone cannot achieve the stated desired conditions:
- Trees need to be removed to meet, promote, or maintain desired conditions for structural stages (see FW-DC-VEG-03. Forest Structure).
- Trees need to be removed to control or limit the spread of insect infestation or disease.
- Trees need to be removed where strategically critical to reinforce, facilitate, or improve effectiveness of fuel reduction in wildland-urban interfaces.
- Trees need to be removed to promote special plant habitats (such as, but not limited to aspen, cottonwood, whitebark pine).

Vegetation Manipulation

Tree stand manipulation as planned for the Sanpoil project complies with requirements found in 16 U.S.C. 1604 for the following reasons:

1. The proposed silvicultural activities are well-suited to the multiple-use goals and objectives established for the Sanpoil planning area when considering the potential environmental impacts associated with their implementation.
2. There is ample assurance that lands proposed for regeneration cutting (created openings in the context of the Forest Plan) will be adequately restocked within five years after harvest, because project design criteria will prevent detrimental soil impacts over >80% of harvested areas and abundant seed sources will remain on-site.
3. The proposed silvicultural prescriptions were not chosen primarily because they would give the greatest dollar return or the greatest output of timber, although these factors were considered when evaluating whether a proposed silvicultural activity was economically feasible.
4. The potential implementation effects on residual trees and adjacent stands were considered when developing the silvicultural proposals.
5. No permanent (e.g., irreversible) impairment of site productivity is expected as a result of the proposed silvicultural activities, and the project's design features, management requirements, and best management practices ensure conservation of soil, slope, and other watershed conditions.
6. Silvicultural activities proposed for implementation in the Sanpoil Project would be prescribed to provide desired effects with respect to water quantity and quality, wildlife and fish habitat, regeneration of desirable tree species, forage production, recreation uses, aesthetic values, and other resource yields.
7. Silvicultural activities proposed for implementation in the Sanpoil Project are considered practical in terms of transportation and harvesting requirements, total financial costs of project preparation, timber harvest, and sale administration, and expected revenues associated with available commercial products.

9 - References Cited

2001 Roadless Area Conservation Rule, mapped in the Roadless Area Conservation FEIS (November 2000)

Agee, J.K., 1993. Fire Ecology of the Pacific Northwest Forests. Island Press, Washington DC.

Agee, J.K.; Skinner, C.N. 2005. Basic principles of forest fuel reduction treatments. Forest Ecology and Management. 211: 83–96.

Alexander M.E., and Frank G. Hawksworth. 1975. Wildland fires and dwarf mistletoes: a literature review of ecology and prescribed burning. USDA For. Ser. GTR RM-14, Rocky Mountain For. and Range Exp. Sta., Ft. Collins, CO.

Barnett, K.; Parks, S.A.; Miller, C.; Naughton, H.T. Beyond Fuel Treatment Effectiveness: Characterizing Interactions between Fire and Treatments in the US. Forests 2016, 7, 237.

Berube, Jay and Bud Kovalchik. 1994. Memo to Forest Supervisor.

Betcha, RL, C.A. Frissell, R.Gresswell, R.Hauer, J.R. Karr, G.W.Minshall, D. A. Perry, JL Rhodes. 1995. Wildfire and salvage logging: recommendations for ecologically sound post-fire salvage logging and other post fire treatments on Federal lands in the West. Corvallis, OR: OSU.

Carroll, M.; Blatner, K.; Cohn, P.; Morgan, T. (2007). Managing Fire Danger in the Forests of the US Inland Northwest: A Classic "Wicked Problem" in Public Land Policy. Journal of Forestry. 105. 239-244.

Churchill, D. Reference conditions, Colville National Forest Vision 2020 monitoring. Powerpoint presentation, 2015

Churchill, D., Kane, J., LeFevre, M., Kane, V., Jeronimo, S., Fischer, Paul., McGoughey, R. 2016. LiDAR User's Guide: Colville National Forest. On file at Republic Ranger District, Colville National Forest, Republic, WA.

Churchill, D.J.; Carnwath, G.C.; Larson, A.J.; Jeronimo, Sean A. 2017. Historical forest structure, composition, and spatial pattern in dry conifer forests of the western Blue Mountains, Oregon. Gen. Tech. Rep. PNWGTR-956. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 93 p.

Churchill, D; LeFevre, M. Stand pattern, Colville National Forest Vision 2020 monitoring. Powerpoint presentation, 2017

Clyatt, K.A.; Crotteau, J.S.; Schaedel, M.S.; Wiggins, H.L.; Kelley, H.; Churchill, D.C.; Larson A.J. 2016. Historical spatial patterns and contemporary tree mortality in dry mixed-conifer forests. Forest Ecology and Management. 361: 23-37.

Continuation of Interim Management Direction Establishing Riparian, Ecosystem and Wildlife standards for Timber Sales. USFS R-6, 1994.

Coop, J. D., DeLory, T. J., Downing, W. M., Haire, S. L., Krawchuk, M. A., Miller, C., Parisien, M.A., Walker, R. B. 2019. Contributions of fire refugia to resilient ponderosa pine and dry mixed-conifer forest landscapes. Ecosphere 10(7):e02809. 10.1002/ecs2.2809

Drew and Flewelling. 1979. Stand density management: An alternative approach and its application to Douglas-fir plantations, Forest Science 25:518-532

Dunn, C.J., O'Connor, C.D., Abrams, J., Thompson, M.P., Calkin, D.E., Johnston, J.D., Stratton, R., Gilbertson-Day, J. 2020. Wildfire risk science facilitates adaptation of fire-prone social-ecological systems to the new fire reality. Environmental Research Letters. 15. 10.1088/1748-9326/ab6498.

Evens A.M., Everett R.G., Stephens, S.L. and Youtz, J.A., May 2011.Comprehensive fuels treatment practices guide for mixed conifer forests: California, Central and Southern Rockies, and the Southwest. Forest Guild, USFS.

Evers, Louisa, Effects of fuels treatment on habitat elements important to survey and manage species. Sept, 2001.

Fettig, C.J.; Klepzig, K.D.; Billings, R.F.; Munson, A.S.; Nebeker, T.E.; Negrón, J.F.; Nowak, J.T. 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States. Forest Ecology andManagement. 238: 24–53.

Flanagan, P., 1998. Evaluation of a Douglas-fir beetle outbreak on the Colville National Forest. USDA Forest Service memo to the Colville National Forest.

Graham, R.; Jain, T.; Sandquist, J. 2007. Free selection: a silvicultural option. In: Powers, R.F., ed. Restoring fire-adapted ecosystems: proceedings of the 2005 national silviculture workshop. Gen. Tech. Rep. PSW-GTR- 203. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 121–156

Graham, R.; McCaffrey, S.; Jain, T., tech. eds. 2004. Science basis for changing forest structure to modify wildfire behavior and severity. Gen. Tech. Rep. RMRS-GTR-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 43 p.

Graham, R.T. and T.B. Jain, 2003. Effectively Integrating Fire and Mechanical Treatments into Silvicultural Systems. Address given at F.S. Inter-Regional Mechanical Fuels Treatment Training, Albuqueque, NM.

Graham, R.T.; Jain, T.B.; Matthews, S. 2010. Fuel management in forests of the Inland West. In: Elliot, William J.; Miller, Ina Sue; Audin, Lisa, eds. Cumulative watershed effects of fuel management in the western United States. Gen. Tech. Rep. RMRS-GTR-231. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 19-68.

Hadfield, J. and Magelssen, R. 2004. Assessment of aspen condition on the Okanogan and Wenatchee National Forests. USDA, Okanogan and Wenatchee National Forests, Wenatchee, Washington.

Hagle, S.K., Tunnock., S. Gibson, K. and Carma J. Gilligan, 1987. Field guide to diseases and insect pests of Idaho and Montana forests. USDA For. Ser. St. and Pvt. For., Northern Region, Missoula, Montana.

Halofsky, J.E., Peterson, D.L. & Harvey, B.J. 2020. Changing wildfire, changing forests: the effects of climate change on fire regimes and vegetation in the Pacific Northwest, USA. fire ecol 16, 4 (2020). https://doi.org/10.1186/s42408-019-0062-8

Hanson, CT 2010. The myth of catastrophic wildfire: a new ecological paradigm of forest health. John Muir Project Tech. Rep.1. John Muir Project of Earth Island Institute, Cedar Ridge, CA.

Harrod RJ, McRae BH, Hartl WE (1999) Historical stand reconstruction in ponderosa pine forests to guide silvicultural prescriptions. For Ecol Manag 114:433–446

Harrod, R.J.; McRae, B.H.; Hartl, W.E. 1999. Historical stand reconstruction in ponderosa pine forests to guide silvicultural prescriptions. Forest Ecology and Management. 114: 433–446.

Haugo, R.D.; Kellogg, B.S.; Cansler, C.A.; Kolden, C.A.; Kemp, K.B.; Robertson, J.C.; Metlen, K.L.; Vaillant, N.M.; Restaino, C.M. 2019. The missing fire: Quantifying human exclusion of wildfire in Pacific Northwest forests, USA. Ecosphere. 10(4): Article e02702.

Henderson, J. 2012. Final Report for Contract AG-05H7-P-10-0029: Revise and update the PAG map and model for the Okanogan, Wenatchee and Colville National Forests.

Henderson, J.A. December 2012. Final report for contract AG-05H7-P-10-0029 "Revise and update the PAG map and model for the Okanogan, Wenatchee and Colville National Forests."

Hessberg, PF, Agee, J.K., Franklin, J.F., 2005. Dry forests and wildland fires of the inland Northwest USA: Contrasting the landscape ecology of the presettlement and modern eras. Forest Ecology and Management 211 (2005) 117-139.

Hessburg PF, Reynolds KM, Salter RB, Dickinson JD, Gaines WL, Harrod RJ (2013) Landscape evaluation for restoration planning on the Okanogan-Wenatchee National Forest, USA. Sustainability 5:805–840

Hessburg, P. F., Miller, C.L., Parks, S.A., Povak, N.A., Taylor A.H., Higuera, P.E., Prichard, S.J., North M.P., Collins, B.M., Hurteau, M.D., Larson, A.J., Allen, C.D., Stephens, S.L., Rivera-Huerta, H., Stevens-Rumann, C.S., Daniels, L.D., Gedalof, Z., Gray, R.W., Kane, V.R., Churchill, D.J., Hagmann, R.K., Spies, T.A., Cansler, C.A., Belote, R.T., Veblen, T.T., Battaglia, M.A., Hoffman C., Skinner, C.N., Safford, H.D., Salter R.B. 2019. Climate, Environment, and Disturbance History Govern Resilience of Western North American Forests. Frontiers in Ecology and Evolution, Vol. 7, 2019. https://www.frontiersin.org/article/10.3389/fevo.2019.00239

Hessburg, P.F., Agee, J.K., and Franklin, J.F. 2005. Dry forests and wildland fires of the inland Northwest USA: contrasting the landscape ecology of the pre-settlement and modern eras. Forest Ecology and Management 211:117-139.

Hessburg, P.F., Churchill, D.J., Larson, A.J. et al. Landscape Ecol (2015) 30: 1805. https://doi.org/10.1007/s10980-015-0218-0

Hessburg, P.F., Spies, T.A., Perry, D.A., Skinner, C.N., Taylor, A.H., Brown, P.M., Stephens, S.L., Larson, A.J., Churchill, D.J., Povak, N.A., Singleton, P.H., McComb, B., Zielinski, W.J., Collins, B.M., Salter, R.B., Keane, J.J., Franklin, J.F., Riegel, G. 2016. Tamm Review: Management of mixed-severity fire regime forests in Oregon, Washington, and Northern California, Forest Ecology and Management, Volume 366, 2016, Pages 221-250.

Hessburg, P.F.; Agee, J.K. 2003. An environmental narrative of Inland Northwest United States forest, 1800-2000. Forest Ecology and Management. 178 (1-2): 23-59.c

Hessburg, P.F.; Churchill, D.J.; Larson, A.J.; Haugo, R.D.; Miller, C.; Spies, T. A.; North, M.P.; Povak, N.A.; Belote, R.T.; Singleton, P.H.; Gaines, W.L.; Keane, R.E.; Aplet, G.H.; Stephens, S.L.; Morgan, P.; Bisson, P.A.; Rieman, B.E.; Salter, R.B.; Reeves, G.H. 2015. Restoring fire-prone landscapes: seven core principles. Landscape Ecology. DOI 10.1007/s10980-015-0218-0.

Hessburg, P.F.; Smith, B.G.; Kreiter, S.D.; Miller, C.A.; Salter, R.B.; McNicoll, C.H.; Hann, W.J. 1999. Historical and current forest and range landscapes in the interior Columbia River basin and portions of the Klamath and Great Basins. Part 1: Linking vegetation patterns and landscape vulnerability to potential insect and pathogen disturbances. Gen. Tech. Rep. PNW-GTR-458. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 357 p. (Quigley, Thomas, M., ed., Interior Columbia Basin Ecosystem Management Project: scientific assessment).

Hessburg,P.F., R.G. Mitchell and G.M. Filip, 1994. Historical and Current Roles of Insects and Pathogens in Eastern Oregon and Washington Forested Landscapes. USDA FS PNW-GTR-327.

Hoffman, C. M., Collins, B., & Battaglia, M. (2018). Wildland fuel treatments. In: Manzello, SL, ed. Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires. Springer, Cham. doi: 10.1007/978-3-319-51727-8_83-1.

Jain, T.B.; Battaglia, M.A.; Han, H.-S.; Graham, R.T.; Keyes, C.R.; Fried, J.S.; Sandquist, J.E. 2012. A comprehensive guide to fuel management practices for dry mixed conifer forests in the northwestern United States. Gen. Tech. Rep. RMRS-GTR-292. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 331 p.

Jain, T.B.; Graham, R.T.; Morgan, P. 2004. Western white pine growth relative to forest openings. Canadian Journal of Forest Research. 34(11): 2187-2198.

Jain, T.B.; Graham, R.T.; Sandquist, J.; Butler, M.; Brockus, K.; Frigard, D.; Cobb, D.; Sup-Han, H.; Halbrook, J.; Denner, R.; Evans, J.S. 2008. Restoration of northern Rocky Mountain moist forests: integrating fuel treatments from the site to the landscape. In: Deal, R.L., ed. Integrated restoration of forested ecosystems to achieve multiple resource benefits: proceedings of the 2007 national silviculture workshop. Gen. Tech. Rep. PNWGTR- 733. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 147–172

Keane, R.E.; Ryan, K.C.; Veblen, T.T.; Allen, C.D.; Logan, J.; Hawkes, B. 2002. Cascading effects of fire exclusion in the Rocky Mountain ecosystems: a literature review. General Technical Report. RMRS-GTR-91. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 24 p.

Kennedy, M.C., Johnson, M.C., Fallon, K., Mayer, D. 2019. How big is enough? Vegetation structure impacts effective fuel treatment width and forest resiliency. Ecosphere 10(2):e02573. 10.1002/ecs2.2573

Koontz, M.J.; North, M.P.; Werner, C.M.; Fick, S.E.; Latimer, A.M. 2020. Local forest structure variability increases resilience to wildfire in dry western U.S. coniferous forests. Ecology Letters. 10.1111/ele.13447.

Larson, A.J.; Churchill, D.J. 2012. Tree spatial patterns in fire-frequent forests of western North America, including mechanisms of pattern formation and implications for designing fuel reduction and restoration treatments. Forest Ecology and Management. 267: 74–92.

Larson, A.J.; Stover, K.C.; Keyes, C.R. 2012. Effects of restoration thinning on spatial heterogeneity in mixed conifer forest. Canadian Journal of Forest Research. 42: 1505–1517.

Lehmkuhl, J.F., Paul F. Hessburg, R. L. Everett, M.H. Huff, and R.D. Ottmar, 1994. Historical and Current Forest Landscapes of Eastern Oregon and Washington. Part 1: Vegetation pattern and insect and disease hazards. USDA FS PNW-GTR-328.

Long, J.N., DeRose, R.J. 2014. Resistance and resilience: A conceptual framework for silviculture. Forest Science, Vol. 60, Issue 6, Pages 1205-1212.

Long, J.N., Windmuller-Campione, M., DeRose, R.J. 2018. Building resistance and resilience: regeneration should not be left to chance. Forests, Vol. 5, Issue 5.

McKetta, Charles, Dan Green and MaryAnn Green. 2016. Economic effects of forest restoration activities on Colville National Forest Vision 2020 projects. Report #4 in a series prepared for: Colville National Forest collaborative working group, Forest Econ INC.

Mehmel, Connie, 2017. Analysis of the 2017 Aerial Survey Data, Republic Ranger District. Email document, Wenatchee Forest Insect and Disease Service Center, Wenatchee, Wa.

Moghaddas, J. J., and Craggs, L. 2007. A fuel treatment reduces potential fire severity and increases suppression efficiency in a Sierran mixed conifer forest. International Journal of Wildland Fire 16:673–678

Moriarty, K., Cheng, A.S., Hoffman, C.M., Cottrell, S.P., Alexander, M.E.. (2019). Firefighter Observations of "Surprising" Fire Behavior in Mountain Pine Beetle-Attacked Lodgepole Pine Forests. Fire. 2. 34. 10.3390/fire2020034.

Oliver, Chadwick D. and Bruce C. Larson, 1990. *Forest Stand Dynamics.* P.153-154, McGraw Hill.

Page,W.G.; Alexander, M.E.; Jenkins, M.J. 2013. Wildfire's resistance to control in mountain pine beetle-attacked lodgepole pine forests. For. Chron. 2013, 89, 783–794.

Pass, J. 2004. A ponderosa pine forest stand and fuel dynamics model. Pullman, WA: Washington State University; M.S. Thesis.

Peterson, D.L.; Johnson, M.C.; McKenzie, D.; Agee, J.K.; Jain, T.B.; Reinhardt, E.D. 2005. Forest structure and fire hazard in dry forests of the Western United States. Gen. Tech. Rep. PNW-GTR-628. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 30 p.

Powell, David C. 2005. Tree density thresholds related to crown fire susceptibility. USFS Colville National Forest, Pendleton, OR.

Reineke, L.H., 1933. Perfecting a stand density index for even-aged forests. J. of Ag. Res. 2:9-17

Ryland, David B., 1996. Evaluating the impact of four silvicultural prescriptions on stand growth and structure in Northeastern Washington – A modeling approach. OSU.

Safford, H.; Stevens J.; Merriam, K.; Meyer, M.; Latimer, A. (2012). Fuel treatment effectiveness in California yellow pine and mixed conifer forests. For. Ecol. Manage., 274, 17–28.

Schlosser, W.E., T.R. King, and V. Bloch, (lead authors). 2006 b. Ferry County, Washington, Community Wildfire Protection Plan. Volume II. Northwest Management, Inc. Moscow, Idaho. December 8 2006. 187 p.

Schmitt, C.L and Powell, D.E. 2005. Rating Forest Stands for Insect and Disease Susceptibility: A Simplified Approach. Version 2.0. BMPMSC-05-01. Blue Mountains Pest Management Service Center. La Grande, OR. 22 p.

Schmitz, R. F. and K.E. Gibson. 1996. Douglas-fir beetle,USDA Forest Service Forest Insect & Disease Leaflet 5, R1-96-87.

Seidel, K. W., July, 1982, Growth and yield of western larch: 15-year results of a levels-of-growing-stock study. PNW Res. Note PNW-398,.

Stephens, S.L.; Collins, B.M.; Fettig, C.J.; Finney, M.A.; Hoffman, C.M.; Knapp, E.E.; North, M.P.; Safford H.; Wayman, R.B. (2018) Drought, tree mortality, and wildfire in forests adapted to frequent fire. Bioscience 68, 77–88. doi:10.1093/BIOSCI/BIX146

Stringer, Darin, 2010, Land Manager's Guide to Aspen Management in Oregon, Chapter 5 Enhancing your aspen through management practices. OSU extension service EM 9005.

The Regional Forester’s Forest Plan Amendment #2 entitled Revised Continuation of Interim Management Direction Establishing Riparian, Ecosystem, and Wildlife Standards for Timber Sales (June 5, 1995).

Thompson, M.P.; Riley, K.L.; Loeffler, D.; Haas, J.R. Modeling Fuel Treatment Leverage: Encounter Rates, Risk Reduction, and Suppression Cost Impacts. Forests 2017, 8, 469.

USDA Farm Bill (2014) (Agricultural Act of 2014, Section 8204 of the Farm Bill)

USDA Forest Service. 2015. FSVeg Common Stand Exam User Guide.

USDA Forest Service. 2019. Colville National Forest Land Management Plan.

USDA FS Forest Health Protection (2006-2015) Forest insect and disease conditions in the United States

USDA FS, R-6, Colville National Forest Plan (1988) as amended in May of 1994.

Voelker, S. L., Merschel, A. G., Meinzer, F. C., Ulrich, D. E. M., Spies, T. A., and Still, C. J. (2019). Fire deficits have increased drought sensitivity in dry conifer forests: fire frequency and tree-ring carbon isotope evidence from Central Oregon. Glob. Change Biol. 25, 1247–1262. doi: 10.1111/gcb.14543

Williams, C.K., Lillybridge, T., and Smith, B.. 1990. Forested Plant Associations of the Colville National Forest. USDA Forest Service, Colville National Forest.